

## V-22 OSPREY



### Navy ACAT IC Program

Total Number of Systems:	458
Total Program Cost (TY\$):	\$37,334M
Average Unit Cost (TY\$):	\$66M
Full-rate production:	2QFY00

### Prime Contractor

Bell-Boeing Joint Venture

### SYSTEM DESCRIPTION & CONTRIBUTION TO JOINT VISION 2010

The V-22 Osprey is a tilt-rotor vertical/short takeoff and landing (VSTOL), multi-mission aircraft developed to fill multi-Service combat ORs. The MV-22 will replace the current Marine Corps assault helicopters in the medium lift category (CH-46E and CH-53D), contributing to the ***dominant maneuver*** of the Marine landing force, as well as supporting ***focused logistics*** in the days following commencement of an amphibious operation. The Air Force requires the CV-22 to provide a long-range VTOL insertion and extraction capability and to supplement the Special Operations Forces (SOF) MC-130 aircraft in ***precision engagement***. The tilt-rotor design combines the vertical flight capabilities of a helicopter with the speed and range of a turboprop airplane and permits aerial refueling and worldwide self-deployment.

Two 6150 shaft horsepower turboshaft engines drive two 38-ft diameter, 3-bladed propellers. The propellers are connected to each other by interconnect shafting which maintains propeller

synchronization and provides single engine power to both proprotors in the event of engine failure. The engines and flight controls are controlled by a triply redundant digital fly-by-wire system.

The airframe is constructed primarily of graphite-reinforced epoxy composite material. The composite structure is intended to provide improved strength to weight ratio, corrosion resistance, and damage tolerance compared to typical metal construction. Battle damage tolerance is built into the aircraft by means of composite construction and redundant/separated flight control, electric and hydraulic systems. An integrated electronic warfare defensive suite including a radar warning receiver, a missile warning set, and a countermeasures dispensing system, will be installed.

## **BACKGROUND INFORMATION**

The V-22 is being developed to meet the provisions of the April 1995 Joint Multi-Mission Vertical Lift Aircraft (JMVX) Operational Requirements Document (ORD) for an advanced vertical lift aircraft. The JMVX ORD calls for an aircraft that will provide the Marine Corps and Air Force with the capability to conduct assault support and long-range, high-speed missions requiring vertical takeoff and landing capabilities.

Since entry into Full Scale Development (FSD) in 1986, the V-22 T&E program has principally concentrated on engineering and integration testing performed by the contractors. Three periods of formal development testing by Naval Air Warfare Center-Aircraft Division, Patuxent River, MD, plus OTA participation in integrated test team activities at Patuxent River provided early insight into the development effort. After transition to EMD in 1992, an integrated contractor/government test team conducted all tests until OT-IIA in 1994. Starting with OT-IIA in 1994, a total of four periods of OT&E have been conducted.

The first three periods of OT&E used test aircraft from the earlier FSD program, with only limited flight time available, and extensive restrictions on allowable flight maneuvers. The main thrust of these OT&E periods was ground tests and simulation.

OT-IIID was conducted from September 1, 1998-October 31, 1998. OT-IIID was the first operational test period to use MV-22 aircraft developed under the EMD program as opposed to prototype aircraft from the earlier FSD activity. OT-IIID was conducted using EMD aircraft numbers 9 and 10, the final two aircraft delivered under the EMD program. OT-IIID consisted of 142.6 flight hours conducting operationally realistic missions in four locations: NAS Patuxent River, MD; New River MCAS, NC; Camp Dawson AAF, WV; and Eglin AFB, FL. Aircraft operations included confined area operations; mountainous area landings; formation flight; use of night vision devices; low altitude terrain tactics; and alternate insertion/extraction procedures performed with Marines and Special Operations Command personnel. Due to the developmental status of the test aircraft, some flight maneuver restrictions and other mission limitations were required, but these limitations did not prevent assessment of the potential operational effectiveness and suitability of the V-22. Of particular note for this stage of OT, Marine Corps and USAF personnel performed all operational-level maintenance on aircraft number 10 throughout OT-IIID, providing valuable insights into the operational suitability of the V-22. In addition, the MOTT broke new ground via their use of a computer-generated warfare environment coupled with manned MV-22 cockpit simulators and actual MV-22 installed-hardware systems at the Navy's Air Combat Environment Test and Evaluation Facility (ACETEF). Using ACETEF, several flight crews conducted realistic Search and Rescue missions in the face of threat defenses, allowing meaningful assessment of the situation awareness and task loading of MV-22 crews in combat conditions.

An LFT&E waiver from full-up, system-level testing was approved on April 25, 1997. Consistent with LFT&E legislation, the program was permitted to execute an alternative plan for LFT&E. The alternative plan, approved by DOT&E prior to the waiver request, includes comprehensive ballistic testing of components and major assemblies.

## **TEST & EVALUATION ACTIVITY**

OT-III, OPEVAL of the MV-22, began on November 2, 1999, for a period of approximately seven months. OPEVAL will be conducted with four MV-22 aircraft, aircraft number 10 from the EMD along with aircraft numbers 11, 12 and 13 from the first LRIP lot. Approximately 700 flight hours are planned.

Under the LFT&E alternative plan, the following components have been subjected to ballistic testing: conversion spindle/pylon support; fuel feed tank; wing torque box; engine; propotor gearbox; propotor controls; sponsons; and wing dry bays.

## **TEST & EVALUATION ASSESSMENT**

Results from OT-IID indicate that the V-22 will provide the required range and payload capabilities needed to meet Marine Corps and Special Operations Forces (SOF) requirements. The V-22 offers significant maneuverability and handling advantages as compared to rotary wing aircraft; e.g., rapid deceleration upon arrival at a landing zone and rapid acceleration during departure. With fully developed tactics, these capabilities should provide substantive maneuver and survivability advantages. In addition, OT-IID results indicated that with modified operational procedures, at least some required tasks could be performed despite the downwash experienced in the rotary mode, which had been an issue of concern in previous OT&E. Most downwash issues, with the exception of shipboard and rescue operations, were assessed favorably in OT-IID. For example, operational pilots demonstrated the ability to conduct mountainous area landings at unprepared sites, as well as being able to deploy a rubber boat and SOF team despite the downwash-induced sea spray generated by V-22 operations only a few feet above the water. Further testing of downwash effects is required, and will be accomplished in OT-III. While the demonstrated capabilities and potential for operational effectiveness are impressive, several areas of concern remain to be resolved:

- Some operations in downwash, such as shipboard operations, rescue from the sea, and special insertion/extraction tasks, remain to be demonstrated.
- Although the OT-IID data was not adequate to support any conclusions regarding system RAM by COMOPTEVFOR and AFOTEC, it appears that some areas affecting operational suitability require improvement; e.g., Mean Time Between Failure, false alarms and spurious caution and warning indications. As acknowledged by the program manager, it is unlikely that the V-22 will meet the ORD requirements for RAM until some time after OPEVAL.

During ballistic LFT&E, the vulnerability of the sponson fuel tanks was significantly greater than expected. Vulnerability Live Fire Test ballistic tests on the sponson and related refueling and fuel transfer lines are being conducted to examine remedial design concepts. Other tests during FY99 included vulnerability testing of: wing auxiliary tanks; fuel cell hydraulic ram (CV-22); pylon-mounted interconnect drive shaft; wing-mounted interconnect drive shaft; propotor gearbox follow-on tests; and

pylon converter actuator. Realistic retest of the sponson to verify the chosen remedial design concepts is planned. Future tests include the tilt-axis gearbox and extensive testing of the EMD Static Test Article.

The automatic fire suppression system, installed in the wing for safety and combat survivability, is credited with extinguishing a fire caused by a mechanical failure in one of the flight test aircraft, thus saving the aircraft from a catastrophic loss.

## **CONCLUSIONS, RECOMMENDATIONS, LESSONS LEARNED**

Close cooperation among those responsible for system acquisition, operational test and the oversight thereof facilitates an understanding of system capabilities and problematic areas, and also helps focus efforts toward specific problems. In this regard, via the opportunity afforded DOT&E representatives to witness OT&E preparation and conduct, some of our previously expressed concerns regarding downwash have been eased, while others are now more precisely focused.

Vulnerability modeling of Live Fire Test ballistic tests is still inadequate to predict vulnerability effects.